ature, respectively. As shown above, $\alpha\epsilon$ and $\beta\theta_m$ are negligibly small, so that,

$$\begin{aligned} p_3 - P_3 &= 0.67\ (\epsilon + \theta_m) \\ &= 0.67\ (p_0 - P_0 + t_m - T_m) \\ &= 0.67\ (p_0 + t_m) - 0.67\ (P_0 + T_m) \\ &= 0.67\ (p_0 + t_m) - \text{a constant.} \end{aligned}$$

This holds if the lapse rate is uniform. When the lapse rate is not uniform, we ought to make some allowance for it so that

$$p_3 - P_3 = 0.67\ (p_0 + t_m + \tau) - \text{a constant.}$$

For our purpose τ can be obtained by rough estimation. From the results of the actual observation of the upper air temperature we can make a table for τ corresponding to various circumstances; e. g., fair weather, rainy, near the surface of discontinuity, morning, evening, summer and winter, continental, oceanic, etc.

We compared the isobars thus constructed with those obtained by the ordinary methods and found good agreement between them. Dr. Nakamura's short memoir also shows the availability of the method.

DISCUSSION.

By C. LE ROY MEISINGER.

It may occasion some surprise to discover that it is really possible to add pressure to temperature at the surface and obtain pressure in the free air. But, as Dr. Fujiwhara says, this is being done every day in Japan. Since the making of pressure maps in the free air is of considerable interest in connection with certain barometry problems in the United States it will be instructive to point out one or two features which may be pertinent to the application of a similar device here.

The level at which a certain increment of pressure at sea-level produces the same effect as a certain increment of temperature applied to the mean temperature of the air column, is given, neglecting the effect of vapor pressure, by the equation:

$$h = 18400 \log \left(\frac{B_0 + \Delta B_0}{B_0}\right) \frac{[1 + \alpha(2\theta + \Delta\theta) + \alpha^2\theta(\theta + \Delta\theta)]}{\alpha\Delta\theta},$$

in which B_0 is the pressure at sea-level, α is 0.00367, the coefficient of gas expansion, θ the mean temperature of the air column, ΔB_0 and $\Delta\theta$ the increments of pressure and temperature, respectively. If, for example, we substitute for B_0, 760 mm., and for θ, 0° C., and for ΔB_0 and $\Delta\theta$, 1 mm. and 1° C., respectively, we obtain 2,818 meters as the value of h. This is the situation assumed by Dr. Fujiwhara; and, since only the horizontal pressure gradients are of interest, it is accurate enough to designate the reduction level as 3,000 meters. If millibars were used instead of millimeters, the level at which pressure and temperature effects are equal is 2,164 meters. Hence, if the Japanese map were drawn in millibars, the reduction level should be approximately 2,000 meters. In this manner any convenient combination of values of ΔB_0 and $\Delta\theta$ may be used. In the ordinary use of the hyspometric equation it is easy to lose sight of this interesting relation.

Would this method be useful in the United States? The answer lies in the difference between the behavior of the small term τ which Dr. Fujiwhara has inserted in his last equation. If the lapse rate is uniform, a difference of 1° C. at the surface would mean a change of 1° C. in the mean temperature of the air column; and, under such conditions, one would be justified in adding temperature to pressure. But when the lapse rate is not uniform, and that is most of the time, it is necessary to correct our sum by the value τ, which depends upon a number of factors, as shown by Dr. Fujiwhara.

Japan is a small country relative to the United States. Its area is about that of the State of California. Moreover, it is surrounded by extensive ocean areas, and its climate is consequently maritime. It is natural that temperature changes at the surface and aloft should not depart markedly from those characteristic of the ocean. In other words, the free-air temperature distribution should be steady and uniform, and thus should tend to diminish irregularities of τ, consequently rendering the method more reliable.

But in the United States, the situation is quite different. The extensive continental area produces strong seasonal variations between inland and coastal regions; and the elevation differences between the east and west, the extremely variable nature of the surface covering, and topographic irregularities, result in a complex of temperature conditions that would make it difficult, if not impossible, to tabulate, as they do in Japan, the probable variation from the uniform lapse rate.

Again, the pressure conditions are more regular above Japan than above the United States. Our country lies in the path of storms moving in from the North Pacific and the result is a pressure situation quite variable from one part of the country to another owing to its great extent. This, combined with the irregular temperature effects mentioned above, would probably effectively militate against the use of such an artifice in this country.